Society Reports.

PHILADELPHIA NEUROLOGICAL SOCIETY.

Vice-President, Dr. Charles W. Burr, in the chair.

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THE SENSE AREAS AND ASSOCIATION CENTRES IN THE BRAIN AS DESCRIBED BY FLECHSIG.

Dr. L. F. Barker, of Johns Hopkins University, Baltimore, read a paper with this title (see this Journal, page 325).

DISCUSSION.

Dr. William Osler, of Baltimore: One interesting point to me in connection with this subject is that twenty years after his early important contributions Flechsig should come forward with work so thorough and so satisfactory, still based upon embryological studies. In 1876, when Flechsig's papers appeared, I translated them with a great deal of industry, and they served me for many years a very important purpose. It is remarkable that this field should have been left practically untilled all these years, except by Flechsig and his students.

Another very interesting point is that these observations, made from the developmental standpoint, should tally so accurately with those which have been made by experimental physiologists and clinicians. The accurate correspondence of the areas which Flechsig has worked out, with those which have been discovered experimentally and by clinical and pathological research, gives a very strong guarantee of the correctness of his studies.

Dr. Charles K. Mills: The Society is under great obligations to Dr. Barker for his admirable paper. The views of Flechsig are not widely known in this country, and, so far as I know, have never before been so carefully and thoroughly presented to an American audience. If accepted, they will compel us to revise the views on the subject of cerebral localization usually held in this country. While this is true, Flechsig's statements are, perhaps, not so revolutionary as they at first sight appear. His views, for instance, in regard to the functions of association areas in the prefrontal and midtemporal cortex are in practical accord with those held by many clinicians and physiologists. The part in cerebral activity assigned by Flechsig to his posterior, or parietal, association area is certainly different from that which is accorded to this region by the majority of observers. I am certainly not in accord with his views regarding the angular, or angulo-occipital, region, believing it to be an area of higher visual representation, as held by Ferrier and others, and, as is well known, I am also not in accord with the views presented regarding the so-called sensori-motor area of the cortex, but I do not believe that it would be well to go into a discussion of this question this evening. One special point in the paper particularly interested me, and that was the statement of Flechsig's views as to the cortical terminus of the entering auditory tract, which, as I understood the speaker, Flechsig places in the convolutions caudad of the insula and within the Sylvian fossa—which are sometimes termed the retroinsular convolutions. In November, 1891, in the *University Medical Magazine*, and later in *Brain*, is reported a case of lesions of the superior temporal convolution. In this case word deafness followed a first apoplectic seizure, and complete deafness, with partial left-sided paralysis, a second apoplectic seizure some years later. An autopsy showed lesions of the first and second temporal convolutions of both hemispheres. The posterior two-thirds, or three-fourths, of the first temporal convolution in this case had shrunken to a thin slip. The retroinsular convolutions were two in number, and the posterior was very small and continuous with the posterior, much-attenuated half of the first temporal convolution.

Dr. William G. Spiller: Dr. Barker's paper is the first, I believe, in the English language in which a clear and lengthy presentation of this subject is given. The German journals have contained many references to Flechsig's views, and the criticism has not been altogether favorable. Some of Flechsig's statements are opposed to the observations of careful investigators. Men of the type of v. Monakow and Dejerine may not be called superficial, and the views which they have advanced after a study of cases for many years may not be put aside without consideration. H. Sachs has raised objections which have not been satisfactorily answered. It is well known that at birth the spinal cord is not fully developed, and that there are few medullated fibres within the brain. Flechsig has based his statements chiefly on the findings in the brains of very young infants at a certain stage of development. The author of the introduction to the new German journal, *Die Monatsschrift für Psychiatrie und Neurologie*, who, presumably, is Wernicke, calls attention to the fact that the brain of an adult is much larger than that of a new-born child. What is the origin and termination of these fibres of later development? Are we to believe that no more projection fibres are formed after a certain period in early life? Sachs' statement, that the intricacy caused by the gradual development of many fibres within the brain makes an examination by Flechsig's method impossible after a certain age, is one of great force. We may accept the results of Flechsig's investigations as representing the condition of the brain at a certain stage, and as such they are of great value, but we would like more proof than has been offered that these relations remain unaltered in the adult.

If there are two areas which may be called association centres, it seems to me that these are the external part of the occipital lobe, with possibly a portion of the parietal, and the island of Reil, though even this is contrary to the statements of v. Monakow. There is a well-known band of fibres which connects the occipital and temporal lobes, and passes in part into the external capsule. Flechsig, I believe, has views in regard to the course of the inferior longitudinal fasciculus different from those held by most writers.

If I understand correctly the statements in regard to the cortical auditory centre, there are, according to Flechsig, fibres which pass from the first temporal gyrus into the external bundle of the peduncle. None of these arise in the second and third temporal gyri. Most investigators have held that this bundle comes from the occipital and temporal lobes. Dejerine and Vialet have shown that the occipital lobe does not give origin to such fibres, and the former, after an examination of six cases, believes that this lateral bundle is formed of fibres from the temporal lobe, chiefly from the second and third convolutions. Dr. Mills and I have studied and reported a case of abscess in the first temporal gyrus, extending very slightly into the uppermost part of the second temporal. There had been positive symptoms for sixty-eight days previous to death, though probably the lesion had existed longer. There was no degeneration in the lateral bundle of the peduncle by the method of Marchi. It seems to us that the case proves that fibres of the lateral bundle do not arise in the first temporal gyrus.

I do not understand the statement regarding the absence of projection fibres in the anterior association centre of Flechsig. It is very probable that this is chiefly an association zone, but if entirely so, in what part of the brain do the fibres of the anterior limb of the internal capsule arise? This is a question which has been asked by others. I present to the Society a few slides from a brain I am now studying. The area nourished by the middle cerebral artery is destroyed. It does not seem possible that fibres pass directly into the anterior limb of the internal capsule posterior to a perpendicular line drawn through the anterior part of the foot of the ascending frontal convolution, as the sclerosis has destroyed the Sylvian area back of this, and yet the anterior limb of the capsule is intact. The case is also in evidence of the correctness of the opinion, already mentioned, held by Dr. Mills and myself. The first temporal gyrus is destroyed, and yet there is no degeneration in the lateral bundle of the peduncle after a lesion which had lasted many years.

Dr. L. F. Barker, of Baltimore: I have been much pleased with the interest which has been evinced by the members of the Society in this subject. The case of double lesion of the temporal lobe in both hemispheres, which Dr. Mills has reported is of great importance. Clinical and pathological evidence shows beyond doubt that destruction of both temporal lobes in the regions referred to, namely, the third-fifth and the fourth-fifth of the superior temporal gyrus and the transverse temporal gyri(or convolutions of the retroinsular region) leads to complete deafness.

I have been especially struck by the remarks of Dr. Spiller, inasmuch as some of the objections he has spoken of are very forcible, and their validity has been recognized by Flechsig himself. A number of the criticisms which have been made by the German neurologists are not, however, so damaging as one might at first think. While they cannot all be satisfactorily answered, yet a number of them have received at least a partial explanation.

In regard to the objection of Sachs concerning the possibility of further medullation after the period when the medullation of the cerebral white matter has become so diffuse that it is impossible to make out the appearance of new bands of fibres, I pointed out in my paper that Flechsig admits that a certain number of fibres may become medullated afterwards, although he does not believe that their number is very great.

I have done wrong if I have left the impression that Flechsig has studied only the brains of the newly born; on the contrary, he has followed up the subject, one might almost say, through every different stage of development, from the sixth month of fetal life to many months after birth, making sections through the whole hemisphere in different instances in various directions. Certain it is that in a babe three months old the sense centres are limited as definitely as he states in his report. It was in the spring of 1894 that Flechsig, while engaged in the study of a series of sagittal sections through the brain of a child three months old, first came to recognize the general principles underlying the development of the white matter of the cerebrum.

From the results of past investigations we have been led to believe that from the formation of definite areas in embryonic development we can draw valuable deductions with regard to function. We must, at any rate from Flechsig's studies, conclude that these sense centres are the principal end stations in the cortex of the various sensory conduction paths. If a certain number of fibres do become medullated later it remains to be determined in how far they really belong to the primary sense centres, and in how far they represent secondary conductions. It may be that the new method of studying the process of medullation, that of Ambronn and Held, in which the polarization microscope is employed, will aid us in settling these problems.

Hitzig, who believes that by the study of secondary degenerations it has been proven that there are some projection fibres belonging to the area designated by Flechsig as the "anterior association centre," admits that there are in this region very few such fibres.

The differences between von Monakow's results and his own have been recently discussed at some length by Flechsig in foot note No. 23 to his published address, *Die Localisation der geistigen Vorgänge*,and to this I would refer any who are interested.

Flechsig's statement regarding the fasciculus longitudinalis inferior of Burdach is, of course, in direct opposition to the views of Dejerine and others who believe it to be a band of association fibres connecting the occipital with the temporal lobe. The evidence that Flechsig brings forward as to the nature of the fibres concerned is suggestive. He says that, at an early period of development, the fibres of the so-called inferior longitudinal fasciculus are medullated before others in their neighborhood, and that they correspond to definite projection fibres of the occipital cortex, namely, to a portion of the optic radiation of Gratiolet. He thinks, further, that certain of the projection fibres run to the uncus; while others, running to the auditory sense area, have been supposed to be a part of this inferior longitudinal fasciculus; whence has arisen the impression that the fibres from this band are distributed to the uncinate gyrus and to the temporal gyrus. Flechsig's views upon this bundle are published in a special note in the *Neurologisches Centralblatt* about a year ago.

The case of abscess of the superior temporal gyrus, which Dr. Mills and Dr. Spiller have reported, with entire absence of degeneration of the lateral bundle of the foot of the peduncle, is of the deepest interest. If no fibres run from the first temporal gyrus into the base of the peduncle, Flechsig's view regarding the cortical origin of the lateral bundle of the base of the peduncle, his *temporale Grosshirnrinden-Brückenbahn* must be modified. In a note appended to his *Gehirn und Seele,* Flechsig states that he cannot define exactly its cortical origin, but that the fibres for the most part can be followed into the first temporal gyrus.

Dr. Spiller further suggests that it seems difficult to believe that the region called by Flechsig the "anterior association centre" is without projection fibres, inasmuch as the anterior limb of the internal capsule is not accounted for. I should have dwelt more at length upon this topic in my review of Flechsig's work, inasmuch as he has offered an explanation of the difficulty. According to his findings in developing brains, several systems of projection fibres run through the anterior limb of the internal capsule, but all are distributed to regions of the cortex behind what he calls his "anterior association centre." Thus he finds in the anterior limb (1) projection fibres running to the frontal olfactory area and to the basal part of the gyrus fornicatus; (2) projection fibres passing to the feet of all the frontal gyri; (3) fibres running to the posterior end of the anterior third and to the whole of the middle third of the gyrus fornicatus, and, finally, (4) the fibres of the frontal cerebrocorticopontal path (Arnold's bundle in the base of the peduncle, Flechsig's *frontale Grosshirnrinden-Brückenbahn*). Curiously enough, some of the projection fibres mentioned, especially those distributed to the foot of the superior frontal gyrus and to the middle third of the gyrus fornicatus, run forward for a long distance, as shown in the diagram, in the white matter of the frontal lobe and arrive within two or three centimetres of the frontal pole. They do not, however, enter into cortical relations in this region, but turn at an acute angle to be distributed in the cortical areas referred to. Cases in which there has been disease of the front part of the frontal lobes, with resulting degeneration of the projection fibres, Flechsig would explain by an involvement of these subcortical projection fibres. He calls the attention of pathologists especially to the fact that in the fore part of the frontal lobe these fibres may easily be affected, and so lead the observer to faulty conclusions.

As I have already said in my paper, there can be but little doubt that a number of the ideas now being promulgated by Flechsig will scarcely stand the test of time. His anatomical studies are, however, of the greatest value, and will prove an immense stimulus to further investigations in the same field. If any one has the right to speculate, it surely is a man who has made as many positive unassailable contributions to our knowledge as has Flechsig. And should he in the field of speculation advance hypotheses which are not well founded we need not fear but that subsequent investigations will soon prove their falsity. Indeed, brilliant speculation even when in error is often a most important spur to accurate investigation. In deciding as to the most important contributions which Flechsig has recently made, all will probably agree with Prof. His, of Leipzig, who suggests that the most stress is to be laid (1) upon the bringing of the anatomical proof of the existence of primary sense centres in the cerebral cortex and of the connection of these centres with the nervous apparatus situated lower down; and (2) upon the determination of the *successive* medullation of the single cortical areas and the exact periods of such medullation.